Docket No. S-98,533

WHAT IS CLAIMED IS:

1. A method of obtaining an emissivity and temperature of a surface, comprising:

calibrating detectors to determine calibration factors C_i/C_n for each channel i of a plurality of channels relative to a reference channel n;

measuring light emitted for the surface as an emitted signal S_i in each channel i;

directing a pulse of incident light from a light source at a known power I_i for each channel i onto the surface;

measuring the emitted signal S_i and a reflected signal R_i from the surface for each channel i; and

calculating the emissivity and the surface temperature in accordance with the following equations:

$$S_i = \varepsilon_i F_i(T) K C_i$$

$$R_i = (1 - \varepsilon_i) I_i H C_i$$

$$A_i = e_i B_i(T)$$

$$D_i = E_i(1 - e_i \varepsilon_n)/(1 - \varepsilon_n)$$

where $e_i = \varepsilon_i/\varepsilon_n$;

$A_i = S_i C_n / S_n C_i$;

$B_i = F_i / F_n$;

$D_i = R_i C_n / R_n C_i$;

$E_i = I_i / I_n$; and

where ε_i is an emissivity of the target surface in channel i;

F_i is a known black body power in channel i as a function of temperature T;

K is a geometry factor which is assumed to be independent of the channel i;

H is a geometry factor that may be assumed to be independent of the wavelength of the channel; and

C_i and C_n are factors that convert light power to signals for each channel i or n.

2. A method of obtaining an emissivity and temperature of a surface of interest, comprising:

directing a pulse of incident light from a light source onto a calibration surface of known reflectivity (r_{ci});

measuring a magnitude of light (S_{ci}) emitted from the calibration surface for selected wavelength intervals i of the spectrum;

directing an identical pulse of incident light from the light source onto the surface of interest;

measuring a magnitude of light (S_i) emitted from the surface of interest for the selected wavelength intervals i of the spectrum;

calculating the emissivity of the surface of interest in accordance with the following relationships:

$$r_i = \frac{S_i}{\frac{S_{ci}}{r_{ci}}} \qquad \varepsilon_i = 1 - r_i$$

where r_i is a reflectivity of the surface of interest in a wavelength interval i,

ε_i is an emissivity of the surface of interest in a wavelength interval i,

subscript c denotes the calibration surface; and

calculating the temperature of the surface of interest in accordance with the following relationships:

$$\frac{A_i}{e_i B_i(T)}$$

where $e_i = \varepsilon_i/\varepsilon_n$;

$A_i = S_iC_n/S_nC_i$;

$B_i = F_i/F_n$; and

C_i/C_n is a calibration factor for wavelength interval i,

F_i is the known black body power in wavelength interval i as a function of temperature T,

S_n is the emission signal in wavelength interval n, and

ε_n is the emissivity of the surface in the wavelength interval n.

3. A method of obtaining an emissivity and temperature of a surface, comprising:

measuring light emitted from the surface in each wavelength interval i as emitted light S_i;

pulsing a light source off of the surface using a known power level I_i in each wavelength interval i;

measuring light from the surface as the sum total (SUM_i) of the emitted light (S_i) and reflected light (R_i) for each wavelength interval i;

subtracting the emitted light S_i from the sum total SUM_i to obtain the reflected light R_i;

determining plots of emissivity (ε_n) versus temperature (T) for each wavelength interval i using the reflected light R_i, the emitted light S_i, and the known power level I_i; and

obtaining the emissivity and temperature of the surface based on the determined plots for each wavelength interval i.

4. The method of claim 3, wherein each of the plots of emissivity (ε_n) versus temperature (T) for each wavelength interval i comprises:

$$\varepsilon_n = \frac{E_i - D_i}{\dfrac{E_i A_i}{B_i(T)} - D_i}$$

where $A_i = S_i C_n / S_n C_i$;

$B_i = F_i / F_n$;

$D_i = R_i C_n / R_n C_i$;

$E_i = I_i / I_n$; and

where C_i/C_n is a relative calibration factor for each wavelength interval i,

F_i is a known black body power in each wavelength interval i as a function of temperature T,

S_n is an emission signal in a wavelength interval n, and

ε_n is an emissivity of the surface in the wavelength interval n.

5. The method of claim 4, wherein obtaining the emissivity (ε_n) and temperature (T) of the surface comprises locating an intersection of the plots with one another.

6. The method of claim 3, further comprising:

shocking the surface prior to measuring the light emitted from the surface in each wavelength interval i as emitted light S_i.

7. The method of claim 6, wherein shocking the target surface comprises:

driving a flyer into the target surface at a given velocity.

8. A method of obtaining an emissivity and temperature of a surface of interest, comprising:

substituting the surface of interest with a highly reflective surface having a known reflectivity (r_{ci});

measuring a reflected signal S_{ci} from the highly reflective surface in each wavelength interval i of a plurality of wavelength intervals;

replacing the highly reflective surface with the surface of interest;

measuring a reflected signal S_i from surface of interest in each wavelength interval i;

obtaining a reflectivity r_i for each wavelength interval i using the following relationship:

$$r_i = \frac{S_i}{\frac{S_{ci}}{r_{ci}}}$$

determining an emissivity (ε_i) for each wavelength interval i according to the following relationship:

$$\varepsilon_i = 1 - r_i$$

plotting, for each wavelength interval i, a ratio of measured power to calculated power normalized to an nth wavelength interval; and

obtaining the temperature of the surface of interest based on the plots for each wavelength interval i.

9. The method of claim 8, wherein the ratio of measured power to calculated power normalized to an nth wavelength interval, for each wavelength interval i, comprises:

$$\frac{A_i}{e_i B_i(T)}$$

where $e_i = \varepsilon_i/\varepsilon_n$;

$A_i = S_i C_n / S_n C_i$;

$B_i = F_i / F_n$;

C_i/C_n is a calibration factor for each wavelength interval i,

F_i is a known black body power in channel i as a function of temperature T,

S_n is an emission signal in a wavelength interval n, and

ε_n is an emissivity of the surface of interest in the wavelength interval n.

10. The method of claim 8, wherein obtaining the temperature of the surface of interest comprises locating an intersection of the plots with one another.

11. The method of claim 8, further comprising:

shocking the surface of interest prior to measuring a reflected signal S_i from the surface of interest.

12. The method of claim 11, wherein shocking the surface comprises:

driving a flyer into the surface of interest at a given velocity.